

## **AMENDMENTS TO THE CLAIMS**

This listing of claims will replace all prior versions, and listings, of claims in the application:

### **Listing of Claims:**

- 1        1. (Currently amended) A method for generating code to perform  
2 anticipatory prefetching for data references, comprising:  
3            receiving code to be executed on a computer system;  
4            analyzing the code to identify data references to be prefetched, wherein the  
5 data references are identified from basic blocks within *if* conditions regardless of  
6 whether the basic blocks are likely to execute, and wherein analyzing the code  
7 involves,  
8            performing a first marking phase in which only data  
9            references located in blocks that are certain to execute are  
10          considered in determining which data references are covered by  
11          preceding data references, and  
12          performing a second marking phase in which data  
13          references that are located in blocks that are not certain to execute  
14          are considered;  
15          calculating a prefetch ahead distance, wherein the prefetch ahead distance  
16          includes the ratio of outstanding prefetches to the number of prefetch streams; and  
17          inserting prefetch instructions into the code in advance of the identified  
18          data references based upon the prefetch ahead distance, wherein inserting prefetch  
19          instructions includes inserting multiple redundant prefetch instructions for a given  
20          data reference;

21       wherein inserting multiple redundant prefetch instructions involves  
22       inserting the multiple redundant prefetch instructions into unused instruction slots,  
23       and wherein executing multiple redundant prefetch instructions potentially avoids  
24       a cache miss.

1       2. (Original) The method of claim 1, further comprising:  
2       profiling execution of the code to produce profiling results; and  
3       using the profiling results to determine whether a given block of  
4       instructions is executed frequently enough to perform the second marking phase  
5       on the given block of instructions.

1       3. (Original) The method of claim 2, wherein determining whether the  
2       given block of instructions is executed frequently enough to perform the second  
3       marking phase involves comparing a frequency of execution for the given block  
4       from the profiling results with a threshold value indicating a minimum frequency  
5       of execution to be considered in the second marking phase.

1       4. (Original) The method of claim 1, wherein analyzing the code involves:  
2       identifying loop bodies within the code; and  
3       identifying data references to be prefetched from within the loop bodies.

1       5. (Original) The method of claim 4, wherein if there exists a nested loop  
2       within the code, analyzing the code involves:  
3       examining an innermost loop in the nested loop; and  
4       examining a loop outside the innermost loop if the innermost loop is  
5       smaller than a minimum size or is executed fewer than a minimum number of  
6       iterations.

1           6. (Original) The method of claim 4, wherein analyzing the code to  
2 identify data references to be prefetched involves examining a pattern of data  
3 references over multiple loop iterations.

1           7. (Original) The method of claim 1, wherein analyzing the code involves  
2 analyzing the code within a compiler.

1           8. (Currently amended) A computer-readable storage medium storing  
2 instructions that when executed by a computer cause the computer to perform a  
3 method for generating code to perform anticipatory prefetching for data  
4 references, the method comprising:

5           receiving code to be executed on a computer system;  
6           analyzing the code to identify data references to be prefetched, wherein the  
7 data references are identified from basic blocks within *if* conditions regardless of  
8 whether the basic blocks are likely to execute, and wherein analyzing the code  
9 involves,

10           performing a first marking phase in which only data  
11           references located in blocks that are certain to execute are  
12           considered in determining which data references are covered by  
13           preceding data references, and

14           |           performing a second marking phase in which data  
15           |           references that are located in blocks that are not certain to execute  
16           |           are considered;

17           |           calculating a prefetch ahead distance, wherein the prefetch ahead distance  
18           |           includes the ratio of outstanding prefetches to the number of prefetch streams; and  
19           |           inserting prefetch instructions into the code in advance of the identified  
20           |           data references based upon the prefetch ahead distance, wherein inserting prefetch

21 instructions includes inserting multiple redundant prefetch instructions for a given  
22 data reference;

23 wherein inserting multiple redundant prefetch instructions involves inserting the  
24 multiple redundant prefetch instructions into unused instruction slots, and wherein  
25 executing multiple redundant prefetch instructions potentially avoids a cache miss.

1       9. (Original) The computer-readable storage medium of claim 8, wherein  
2 the method further comprises:

3       profiling execution of the code to produce profiling results; and  
4       using the profiling results to determine whether a given block of  
5 instructions is executed frequently enough to perform the second marking phase  
6 on the given block of instructions.

1       10. (Original) The computer-readable storage medium of claim 9, wherein  
2 determining whether the given block of instructions is executed frequently enough  
3 to perform the second marking phase involves comparing a frequency of  
4 execution for the given block from the profiling results with a threshold value  
5 indicating a minimum frequency of execution to be considered in the second  
6 marking phase.

1       11. (Original) The computer-readable storage medium of claim 8, wherein  
2 analyzing the code involves:

3       identifying loop bodies within the code; and  
4  
5       identifying data references to be prefetched from within the loop bodies.

1       12. (Original) The computer-readable storage medium of claim 11,  
2 wherein if there exists a nested loop within the code, analyzing the code involves:

3               examining an innermost loop in the nested loop; and  
4               examining a loop outside the innermost loop if the innermost loop is  
5       smaller than a minimum size or is executed fewer than a minimum number of  
6       iterations.

1               13. (Original) The computer-readable storage medium of claim 11,  
2       wherein analyzing the code to identify data references to be prefetched involves  
3       examining a pattern of data references over multiple loop iterations.

1               14. (Currently amended) The computer-readable storage medium of claim  
2       8-claim 11, wherein analyzing the code involves analyzing the code within a  
3       compiler.

1               15. (Currently amended) An apparatus that generates code to perform  
2       anticipatory prefetching for data references, comprising:  
3               a receiving mechanism that is configured to receive code to be executed on  
4       a computer system;  
5               an analysis mechanism that is configured to analyze the code to identify  
6       data references to be prefetched, wherein the data references are identified from  
7       basic blocks within *if* conditions regardless of whether the basic blocks are likely  
8       to execute, and wherein the analysis mechanism is configured to,  
9               perform a first marking phase in which only data references  
10      located in blocks that are certain to execute are considered in  
11      determining which data references are covered by preceding data  
12      references, and to  
13      perform a second marking phase in which data references  
14      that are located in blocks that are not certain to execute are  
15      considered;

16        a calculating mechanism that is configured to calculate a prefetch ahead  
17        distance, wherein the prefetch ahead distance includes the ratio of outstanding prefetches  
18        to the number of prefetch streams; and

19            an insertion mechanism that is configured to insert prefetch instructions  
20        into the code in advance of the identified data references based upon the prefetch  
21        ahead distance, wherein inserting prefetch instructions includes inserting multiple  
22        redundant prefetch instructions for a given data reference;

23            wherein inserting multiple redundant prefetch instructions involves  
24        inserting the multiple redundant prefetch instructions into unused instruction slots,  
25        and wherein executing multiple redundant prefetch instructions potentially avoids  
26        a cache miss.

1            16. (Original) The apparatus of claim 15, further comprising a profiling  
2        mechanism that is configured to profile execution of the code to produce profiling  
3        results;

4            wherein the analysis mechanism is configured to use the profiling results  
5        to determine whether a given block of instructions is executed frequently enough  
6        to perform the second marking phase on the given block of instructions.

1            17. (Original) The apparatus of claim 16, wherein the analysis mechanism  
2        is configured to compare a frequency of execution for the given block from the  
3        profiling results with a threshold value indicating a minimum frequency of  
4        execution to be considered in the second marking phase.

1            18. (Original) The apparatus of claim 15, wherein the analysis mechanism  
2        is configured to:  
3            identify loop bodies within the code; and to  
4            identify data references to be prefetched from within the loop bodies.

1           19. (Original) The apparatus of claim 18, wherein if there exists a nested  
2       loop within the code, the analysis mechanism is configured to:  
3           examine an innermost loop in the nested loop; and to  
4           examine a loop outside the innermost loop if the innermost loop is smaller  
5       than a minimum size or is executed fewer than a minimum number of iterations.

1           20. (Original) The apparatus of claim 18, wherein the analysis mechanism  
2       is configured to examine a pattern of data references over multiple loop iterations.

1           21. (Original) The apparatus of claim 15, wherein the apparatus resides  
2       within a compiler.

1           22-45 (Canceled).